HEAT PUMP SYSTEM AND METHOD FOR AIR-CONDITIONING

The present invention relates to heat pump systems and in particular to heat pump systems utilizing two subcycles, the first involving brine and the second a common refrigerant. The invention also relates to a method of air conditioning, utilizing the heat pump systems.

Space heating and cooling installations are known. Essentially, such installations comprise a closed top refrigerant circulated by means of a compressor through finned pipes located inside a house and outside thereof. In winter, the compressor forces compressed and warmed refrigerant into finned pipe sections within the house where condensation takes place. The liberated heat is usually dispensed into the house by means of a fan. The condensed refrigerant then passes through a throttle valve to an evaporator. The heat of evaporation is provided by the colder outside air. During summer, the sense of circulation of the refrigerant is reversed. The outside finned pipes constitute the condenser, while the inside finned pipes operate as the evaporator.

When such installations are used in areas where the climate is not mild, however, i.e., where the outside air temperature drops to close to the freezing mark or even therebelow, ice can accumulate on the surfaces of the outdoor evaporator and obstruct the air flow.

It is therefore a broad object of the present invention to ameliorate the above problem and to provide a heat pump system adapted to operate efficiently also in more severe climatic conditions.

It is a further object of the present invention to provide a heat pump system utilizing brine in heat exchange relationship with a refrigerant.

In accordance with the present invention there is therefore provided a heat pump system, comprising two, at least similar units in fluid communication with each other, each unit including a housing, a first air/brine heat exchanger, a second brine/refrigerant heat exchanger, brine inlet means for applying brine onto at least one of said heat exchangers, a brine reservoir and means for circulating said brine from the reservoir to said inlet means, said first and second heat exchangers being in closed loop fluid communication with each other and having compressor means for circulating a refrigerant therethrough in selected directions.

The invention further provides a method for air conditioning, comprising providing a housing, a first air/brine heat exchanger, a second brine/refrigerant heat exchanger, brine inlet means for applying brine onto at least one of said heat exchangers, a brine reservoir and means for circulating said brine from the reservoir to said inlet means, said first and second heat exchangers being in closed loop fluid communication with each other and having compressor means for circulating a refrigerant therethrough in selected directions, wherein the refrigerant's evaporator and the refrigerant's condenser exchange heat with brine solution, whereby the temperature of condensation of said refrigerant is reduced while the temperature of said evaporator is raised, thereby increasing the efficiency of the system.

Hygroscopic brine such as LiBr, $MgCl_2$, Ca_2cl and mixtures thereof, can be advantageously used. The concentrations of these brines will be such that no precipitation of salts or ice throughout the working range of temperatures of the heat pump will be formed.

The invention will now be described in connection with certain preferred embodiments with reference to the following illustrative figures so that it may be more fully understood.

With specific reference now to the figures in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

IN THE DRAWINGS:

FIG. 1 is a schematic illustration of a heat pump system according to the present invention;

FIG. 2 is a schematic illustration of another embodiment of a heat pump according to the present invention, and

FIG. 3 is a modification of the heat pump of FIG. 1.

Seen in the Figure is a heat pump system **2** essentially comprising two substantially similar units **4** and **6**, each acting in its turn as an evaporator and a condenser, one located inside an enclosure (not seen) to be air conditioned and the other, outside the enclosure exposed to ambient air. Each unit respectively includes a housing **8,8'** and brine inlet means **10,10'** disposed in the upper portion of the housing. The liquid inlet means is advantageously embodied by a set of drip or spray nozzles or apertures. Below the brine inlet means **10,10'** there is affixed a brine/air heat exchanger **12,12'**. The latter can be made of densely folded carton paper or of packed particles, e.g., glass or ceramic, pebbles of beads. The lower portion of the housing constitutes a brine reservoir **14,14'** while the space **16,16'** inside the housing delimited by the liquid level **18,18'** and the heat exchanger **12,12'**, respectively, acts as a brine dripping space exposed to ambient air introduced thereinto, for example, by a blower **20,20'** or by any other natural or forced means. Each of the brine inlet means **10,10'** is respectively connected via conduit **22,22'** to a second heat exchanger **24,24'**. A conduit **26,26'** leads from the heat exchanger **24,24'** to the brine reservoir **14,14'** via a circulation pump **28,28'**, respectively. The reservoirs **14,14'** are in liquid communication via conduits **30** and **32** and advantageously, pass through a third heat exchanger **34**.

The heat exchangers **24,24'**, in their simple embodiment are composed of a closed vessel **36,36'** each housing a coil **38,38'**, respectively. The coils **38,38'** are interconnected, in a closed loop, by pipes **40,42**. A compressor **44** fitted on the pipe **40** forces a refrigerant through the coils **38,38'** via a throttle valve **46**.

If not all, at least most, of the system's parts and components should be made of materials non-corrosive to brine.

In order to avoid the necessity of providing synchronization and control between the pumps **28,28'**, it is proposed to build the system such that the brine accumulated in the reservoir **14'** will return to the reservoir **14** through conduit **32** as gravity flow. This is achieved by locating the reservoir **14'** at a higher level than the level of reservoir **14** or at least inter-connecting the reservoir's conduit **32** in such orientation so as to slope from reservoir **14'** to reservoir **14**. In any case, the brine exchange flow rate between the reservoirs **14,14'** via pipes **30,32** should be smaller than the circulation rate of the brine in the units **4** or **6** themselves. For operation under certain conditions, it is also possible to stop the circulation of the brine between the two units, if desired.

The size of the reservoirs will determine the capacity thereof acting as heat accumulators for eventual utilization.